Date.	G.M.T.	Apparent R.A.	Apparent Dec.	Log Δ.	Corr. for Parallax. R.A.	Corr. for Parallax. Dec.
1904	h m s	h m s	° ′ ″		s	″
Sept. 19	7 45 44	12 23 52·66	42 51 14·2	0·6071	+·12	+1·5
20	7 42 26	12 24 12·69	42 49 4·6	0·6074	+·12	+1·5
Oct. 3	7 13 55	12 28 39·55	42 35 54·8	0·6090	+·11	+1·6
12	7 3 2	12 31 42·34	42 43 45·6	0·6076	+·11	+1·7
1905.						
Jan. 17	12 25 0	11 39 30·61	60 33 58·1	0·5471	−·17	+ ·1
25	11 48 7	11 16 58·30	62 19 41·0	0·5489	−·16	·0
Feb. 2	11 33 34	10 50 35·30	63 39 12·9	0·5536	−·14	− ·3
25	11 37 46	9 28 25·59	64 15 16·9	0·5816	+·03	− ·5
Apr. 12	10 21 6	8 3 36·90	56 41 20·8	0·6720	+·12	+ ·2
May 8	10 16 29	7 57 26·30	52 11 12·0	0·7223	+·11	+ ·7

Further details of the observations will be given in the volume of "Greenwich Observations."

Royal Observatory, Greenwich:
1906 *April* 10.

Note on the Effects of Difference of Sea and Air Temperatures on Marine Refraction. By the Rev. William Hall, R.N.

(*Communicated by the Secretaries.*)

Observers who use the sea-horizon are often confronted with a displacement of the visible horizon, which, while not amounting to *mirage*, is nevertheless capable of disturbing their "sights." It would appear that very little exists upon which to base a theory of such abnormal refraction, since none of the recognised text-books of nautical astronomy refer to it. I submit a few suggestions.

My attention was first drawn to the subject in 1897, when, in observing equal altitudes of the Sun for rating chronometers at Ras-el-Tin, Alexandria, I found a remarkable discrepancy in results, and was led to connect it with a *mirage* which occurred intermittently during the day. On the next days I took temperatures of air and of the sandy soil and obtained a series of about seven days' observations—about four sets per day—and tried graphic methods of getting some connection between the true and apparent altitudes. It seemed that a formula of the shape

$$R = a + bT^2$$

was indicated, T being difference of temperatures of air and sand.

My results were retained with a view to further experiment,

but the question was not again attacked until 1899, when some observations were made in latitudes ranging between 65° N. and the Equator. Finally, in 1903, continuous observations in the Mediterranean were made during the summer; there were then sufficient data to warrant analysis.

I suggest now that the temperature difference causes an abnormal refraction of two terms

$$R = f(h) + \phi(T)$$

$f(h)$ depends on h, the height of observer's eye, and is constant for a given height of eye. $\phi(T)$ depends on T, the temperature difference, and on h.

I cannot trace any connection between apparent altitude and the correction, although *à priori* one would expect that $\phi(T)$ would involve also the altitude and would vanish at alt. $= 90°$. Here, however, I admit there are but few data for high altitudes.

The following formula is given as a subject for criticism in the hope that it may either be proved reasonably correct or else be corrected by other observers :—

$$R = \tfrac{1}{20}\text{ dip.} + cT \text{ (plus to alt. when sea is colder.)}$$

where $c =$	11·4″	for height	0 feet
	11·7	,,	20
	12·0	,,	40
	12·4	,,	60
	12·0	,,	80
	11·7	,,	100

On this it may be remarked that the formula represents the consensus of upwards of 300 observations, giving due weight to separate results according to their distance from the first average.

A point on which any information would be welcomed is this. The term "$\frac{1}{20}$ dip." *changes sign suddenly* as T changes sign. Thus the function is *discontinuous*. I hope that this may be connected with a "critical angle" as in ordinary refraction of transparent substances, but I am unable to justify my conclusions by theory.

Again, I cannot believe that altitude does not affect the correction. But in all probability the disturbance takes place almost entirely in the line of sight from eye to horizon, and hardly at all in that from eye to Sun. Thus an effect of altitude would be masked by errors of observation.

It remains to add that *time* enters into the question. That is, the warming of the air after sunrise lags behind the warming of the mercury in thermometer. Thus a maximum or minimum effect occurs about 2 P.M.—in general it is a minimum.

But, on the contrary, the shift of horizon is plainly observable when a squall drifts up from windward. And (though this is not

directly applicable) the settling down of fog makes a marked difference, more than is accounted for by the usual corrections given by Bessel.

A provisional table is appended. It must be taken as including seconds of arc, not because these are reliable, but because only thus could advantage be taken of the analysis of many observations.

TENTATIVE TABLE

of correction to altitude due to shift of horizon caused by difference of temperature of sea and air (after applying to mean refraction the corrections for state of barometer and thermometer).

Sea colder, *plus* to alt.
Sea warmer, *minus* to alt.

Arguments :—Height of eye, feet
Difference of sea and air, degrees F.

Diff. Fahr.	Height of Eye, Feet. 0 or 140	20 or 120	40 or 100	60 or 80	Diff. Fahr.	Height of Eye, Feet. 0 or 140	20 or 120	40 or 100	60 or 80
°	′ ″	′ ″	′ ″	′ ″	°	′ ″	′ ″	′ ″	′ ″
1	11	25	31	35	7	1 20	1 35	1 43	1 50
2	23	36	43	48	8	1 31	1 47	1 55	2 2
3	34	48	55	1 0	9	1 43	2 0	2 7	2 15
4	46	1 0	1 7	1 13	10	1 54	2 12	2 19	2 27
5	57	1 11	1 19	1 25	20	3 48	4 6	4 19	4 31
6	1 8	1 23	1 31	1 37	30	5 42	6 3	6 19	6 35

Example :—Sea warmer by 23°, H.E. 30 feet

for 20°	4′	12″
3		52
	5	4 — to alt.

1906 *March* 15.

On Planetary Inversion. By F. J. M. Stratton, B.A.

I. *Introduction.*

§ 1. The question considered in the following paper is the influence of tidal friction in producing secular changes in the obliquities of the members of the solar system. This subject was suggested by some remarks of Professor W. H. Pickering in his